# A PROSPECTIVE STUDY OF

# FUNCTIONAL OUTCOME OF DISTAL FIBULA FRACTURES WITH SYNDESMOTIC INJURY MANAGED BY ANATOMICAL LOCKING COMPRESSION PLATE AND SYNDESMOTIC SUTURE BUTTON FIXATION

Dissertation submitted to

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# CERTIFICATE

This is to certify that this dissertation entitled '**FUNCTIONAL OUTCOME OF DISTAL FIBULA FRACTURES WITH SYNDESMOTIC INJURY MANAGED BY ANATOMICAL LOCKING COMPRESSION PLATE AND SYNDESMOTIC SUTURE BUTTON FIXATION'** is a record of bonafide research work done by **Dr. S.ROHIT**, post graduate student under my guidance and supervision in fulfilment of regulations of The Tamilnadu Dr. M.G.R. Medical University for the award of M.S. Degree Branch II (Orthopaedic Surgery) during the academic period from 2014 to 2017, in the Department of Orthopaedics, Govt. Kilpauk Medical College, kilpauk, Chennai-600010.

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# DECLARATION

I **Dr.S.ROHIT,** solemnly declare that the dissertation, '**FUNCTIONAL OUTCOME OF DISTAL FIBULA FRACTURES WITH SYNDESMOTIC INJURY MANAGED BY ANATOMICAL LOCKING COMPRESSION PLATE AND SYNDESMOTIC SUTURE BUTTON FIXATION''** is a bonafide work done by me in the Department of Orthopaedics, Govt. Kilpauk Medical College, Chennai under the guidance of Prof. K. Raju, M.S.Ortho., D.Ortho., Professor of Orthopaedic Surgery, Govt. Kilpauk Medical College, Chennai-600010.

This dissertation is submitted to "THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY", towards partial fulfilment of regulations for the award of M.S.DEGREE BRANCH II (Orthopaedic Surgery).

Place: Chennai

Date: Signature

# CONTENTS

# INTRODUCTION

Ankle joint is a complex weight bearing joint. It enables lots of thrust forces to pass through the joint on weight bearing. Ankle fractures contribute 10% of all fractures[(1)]. It is the second most common fracture involving the lower limb. These fractures usually occur at an age above 45 when the bones become osteoporotic.

A fracture involving the distal fibula can occur due to various mechanisms which have been studied in detail. Common association with distal fibula fractures are associated syndesmotic injury which most of the times goes unnoticed.

Distal fibula fractures commonly occur in older osteoporotic bones and can even happen in younger individuals. It is usually associated with a small communited distal fragment. Conventional low profile plating methods have been associated with lesser screw purchase on osteoporotic bones and only one or two screws at the most can be applied. Stabilization of the fracture with an implant which provides increased fixation strength can decrease failure rates and provide better functional treatment.

Syndesmotic injury can occur after trauma to the ankle, both with and without a fracture. In fractures of the ankle, syndesmotic injury occurs in about 50% of type Weber B and in all type Weber C fractures.

In ankle sprains without fracture, syndesmotic injury accounts for 1–11% of all injuries[2]. Syndesmotic diastasis left unnoticed can lead to persisting pain , instability and progressive arthritis.

Conventional treatment modality for fixation of the syndesmotic injury when diagnosed is with the help of screw fixation , one or two screws depending upon the fracture pattern and the instability. Screw fixation has been associated with many shortcomings as it converts the distal tibiofibular joint into a rigid joint and has got screw related complications like breakage, infection and difficulty at the time of removal.

This study focusses on the application of syndesmotic suture button anchor as a fixation method for the syndesmotic joint diastasis. The syndesmotic button fixation does not convert the joint into a rigid articulation and still allows micro motion to happen. This maintainance of normal physiological movement

at the joint reflects on the recovery time and functional outcome of the patient. This study is done to confirm such a correlation.

In this study, Distal fibular fractures with syndesmotic injuries are selected and anatomically precontoured locking compression plate is applied for fracture fixation and syndesmotic suture button fixation is done for the syndesmotic injury and their functional outcomes studied by various modalities.

# AIM OF THE STUDY

To study the functional outcome of distal fibula fractures with syndesmotic injury managed by distal fibula anatomical locking compression plate and syndesmotic suture button fixation.

# REVIEW OF LITERATURE

The treatment for distal fibular fracture depends upon the fracture pattern .The various treatment modalities available are conservative management with application of short leg cast or surgical fixation by lag screws, plates and screws, intramedullary nail or external fixation. The main goal of open reduction and internal fixation is to restore joint congruity.

**Ramsey and Hamilton** (1976) said 1mm lateral shift of talus in the ankle mortise reduces the contact area by 42 %[3]. Posterior malleolus fractures have to be rule out before planning for any fixation.

**Phillips et al** stated Open reduction is the treatment modality in young adults if there is a displacement of 1mm or 2 degrees of talar tilt[4].

The main factor to worry in conventional plating system is the distal fragment screw purchase. Usually with conventional plating technique a low profile one third tubular plate with two screws at the most are applied. But this carries the danger of increased failure rate especially in elderly individuals.

Fixation of experimentally induced distal fibular fractures of cadavers with precontoured locking plate has shown better stability when compared to conventional plating[5].

Conventional plating have increased predisposition to **higher failure rates** including screw or plate loosening when compared with locking plate fixation[5,6]. The locking plate system provided higher torque to failure levels when compared to the conventional plating system[5].

**Kim et al** reported that, 2 distal unicortical locking screws are mechanically equivalent to a conventional one third tubular plate with 3 distal screws[6].

Distal fibula LCP achieves better OMS & AOFAS scores and has better healing time when compared to one-third tubular plate[7].

Suture button fixation consists of two metallic buttons connected with thick fiber wire sutures. The two buttons stabilize the either side of the bony framework providing compression with the help of a fiber wire. Prior reduction is mandatory before application of any implant be it screw or suture button fixation.

Proper Reduction and surgical stabilization of the syndesmotic diastasis is necessary to prevent lateral talar shift and arthritis [8].

Syndesmotic screw are conventionally used but are associated with increasing reports of screw breakage, loosening[9] and stiffness due to prolonged immobilization to protect the screw. Also there is need for a second surgery to remove the screw.

**Klitzman et al** suggested that flexible fixation of the syndesmotic injury will lead to better physiological healing [10] **Thornes et al** suggested that fixation of syndesmotic diastasis with suture button was a safe, easy and cost effective method when compared to the screw fixation [11] and the patients also returned to their day to day activities very early when compared to the conventional treatment. None of the patients treated by suture button required any re-surgery for implant removal [11].

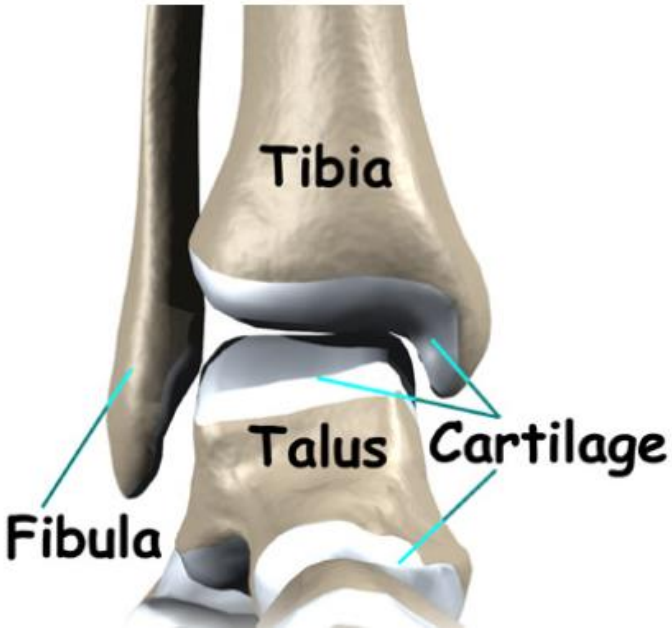
**Coetzee and Ebeling** suggested that the use of suture button for fixation provided better range of movements and decreased discomfort[12].

The suture button provides a pulley effect which provides an extra small squeeze, which aids in reduction of the joint.

The normal reduction maneuver should not be compromised and the fibula should be placed in the incisura before the application of any implant.

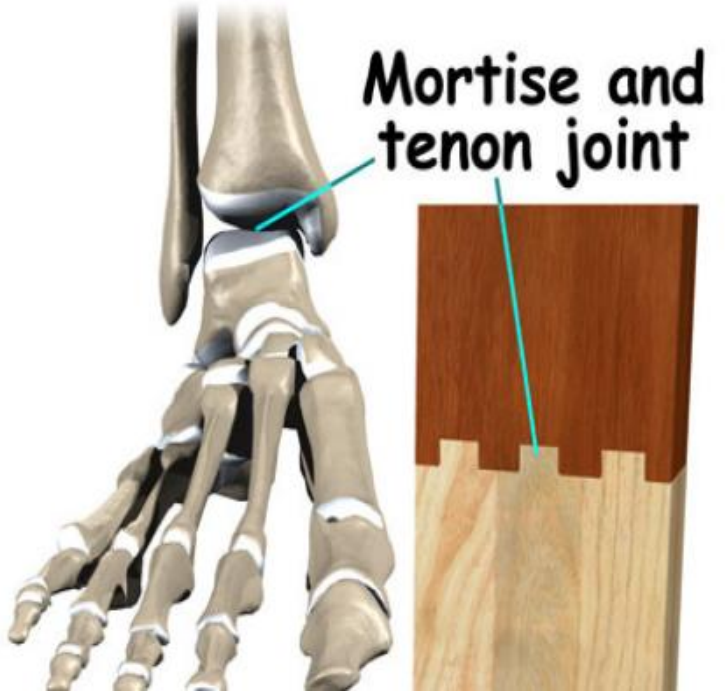
# REVIEW OF ANATOMY

Ankle joint acts like a hinge. The unique design of the ankle makes it a very stable joint. This joint has to be stable to withstand 1.5 times the body weight during walking and up to eight times the body weight while running.




The ankle joint or the Talocrural joint is a synovial joint formed between the Tibia, Fibula and the talus. The tibia and fibula are bound together with tibiofibular ligaments which forms a bracket shaped socket, covered by hyaline cartilage to form a structure known as a mortise.

The lateral articulation of the talus is with the distal fibula. The medial malleolus is shorter and anterior making the axis of the joint 15 degrees of external rotation [1].



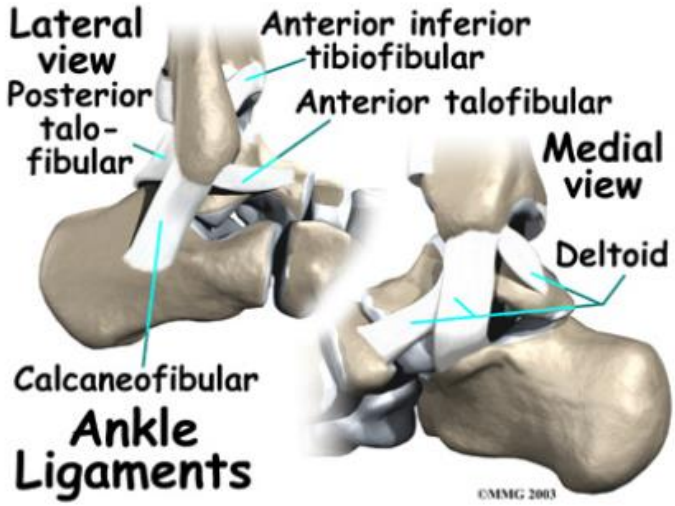

The body of the talus snugly fits into the mortise. The articulating part of the talus is wedge shaped .It is wider anteriorly and thinner posteriorly.

The bones forming the joint are covered by a slick material called articular cartilage. Articular cartilage facilitates smooth movement to happen at the joint. It is soft enough to act as a shock absorber during weight bearing.

## LIGAMENTS

Ligaments are soft tissues that interconnect the osseous components. In the ankle joint there are two ligamentous components, the medial ligamentous structures and the lateral ligamentous structures. Medially the deltoid ligament (medial collateral ligament) has got two components.

The superficial part originates from the anterior colliculus of the medial malleolus and inserts to the talus, navicular and calcaneum.




The deep part extends from the posterior colliculus to the dome of the talus. The deep component restrains the talus against lateral displacement and rotation [13].

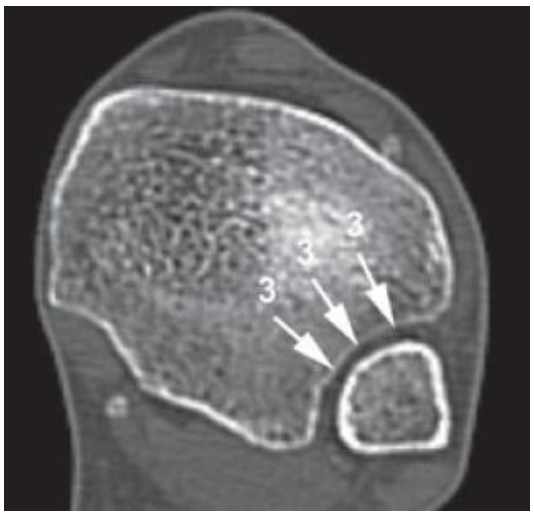
Three main ligaments support the lateral side of the ankle, together known as the lateral collateral ligament. These are the anterior talofibular ligament, calcaneofibular ligament and the posterior talofibular ligament.

## SYNDESMOTIC JOINT

Syndesmotic joint is a fibrous joint in which the distal tibia and fibula are attached by means of a fibrous membrane and ligaments.

### Bony Component

The lateral aspect of the distal tibia takes part in forming the syndesmotic joint with the fibula. The lateral joint forming surface bifurcates anteriorly and posteriorly into two ridges and forms a concave triangle for the fibula to get attached .the anterior tubercle is also called as CHAPUTS TUBERCLE.



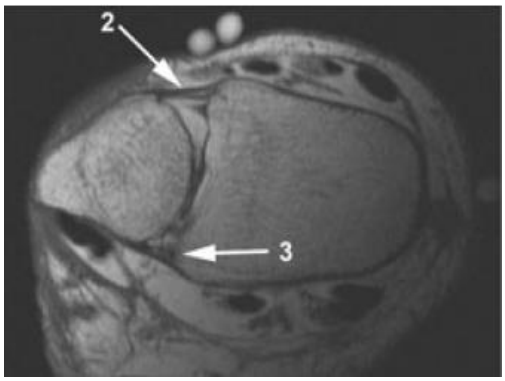
The fibular component also bifurcates in a similar fashion into anterior and posterior tubercles, anterior being more prominent and forma a convex triangle and forms an ideal counterpart for the concave tibial lateral surface. This medial aspect of distal fibula is the cristae incisurae fibularis. The anterior tubercle of the fibula is called the WAGSTAFFE TUBERCLE.

## LIGAMENTS

There are four syndesmotic ligaments

### 1. Anterior tibiofibular ligament (ATFL)

It is an oblique ligament that extends from the anterior tubercle of the tibia to the anterior tubercle of the fibula. It is either as a single thick strand or at times can be in the form of two or three separate strands. It is considered to be the weakest of all the four ligaments and it is the first ligament to get injured with excessive external rotation force [14].



**2. Posterior Tibiofibular ligament (PTFL)**

It is a strong ligament extending from the posterior malleolus to the posterior tubercle of the fibula. It is composed of many bundles and has greater resistance to injury. It is usually ruptured in severe external rotation injuries and is often associated with an avulsion fracture.

**3. Transverse ligament**

It is a small band of ligament lying just below the PTFL, it extends from the fibular malleolar fossa to the dorsal rim of the tibia and reinforces the posteroinferior aspect of the syndesmosis. Controversy exists if it is an isolated ligament or a part of the PTFL.

**4. Interosseous ligament**

It is a transverse membrane that extends horizontally from the tibia to the fibula. It gets thickened at its lower margin to form a ligamentous structure. It is composed of fatty tissue. It acts like a spring and separates the two malleoli during ankle dorsiflexion. It acts as a buffer. It also helps in stabilizing the talocrural joint during loading [(15)].

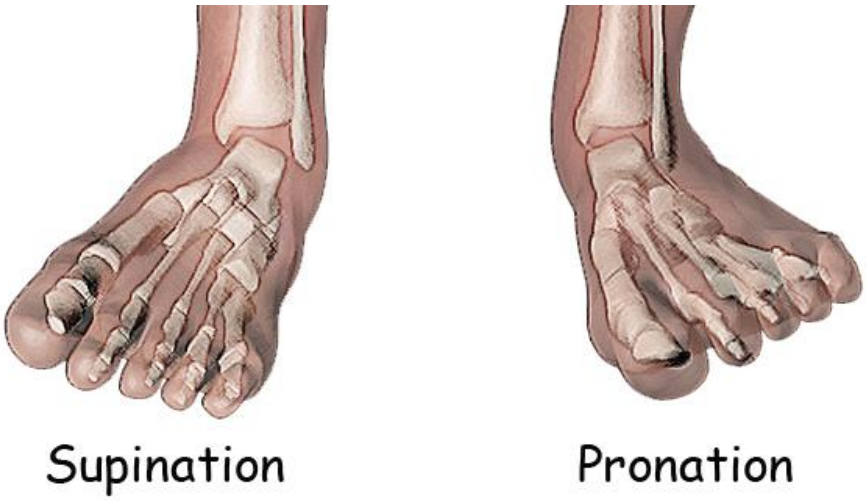
Several anatomical studies were made to determine the role of the syndesmotic ligaments in the syndesmotic joint stability and ATFL – 35%, Transverse ligament-33%, Interosseous ligament-22%, PTFL–9%[16] were the percentage of joint stability provided by individual ligaments. Many studies have evaluated the exact amount of relative movement occurring between the tibia and the fibula. From extreme plantarflexion to dorsiflexion, it moves 0.82–3 mm laterally, 0.9–1.34 mm posteriorly and externally rotates 0.5°–3.7° [17,18] .

## MECHANISM OF INJURY

The mechanism of injury causing ankle fractures have been studied in detail. The ankle joint can be considered like a ring where the bony and the ligamentous structures form integral part. Any injury to the ligaments or fractures will destabilize the ring and cause loss of stability of the ankle joint.

The medial compartment of the ankle joint the medial malleoli and the medial collateral ligament are quite rigid, whereas the lateral compartment and the ligaments are flexible during the ankle motion.

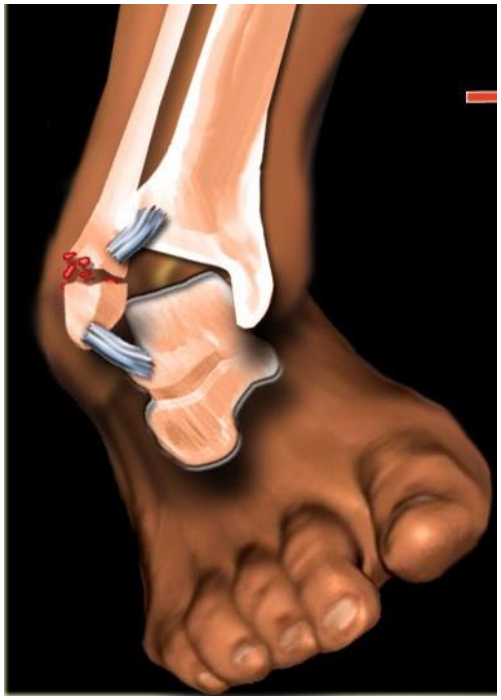
The two main movements that causes ankle injuries are supination and pronation. Supination injuries are the commonest and such injuries begin with a fracture or a ligamentous injury on the lateral aspect of the ankle. Pronation injury begins with either an avulsion fracture of the medial side or a ligamentous injury on the medial side.




Lauge-Hansen proposed a classification based on the position of the foot at the time of injury and the deforming forces that caused the injury [19].

**SUPINATION ADDUCTION**

This injury occurs when a supinated foot is forcefully adducted. This type of injury usually is associated with a ligamentous rupture on the lateral aspect with a transverse fracture of the fibula below the level of syndesmosis. Associated syndesmotic injury in this mechanism is rare. Medial side is associated with a vertical shear fracture of the medial malleolus.



**SUPINATION EXTERNAL ROTATION**

This is the commonest mechanism that causes ankle fractures - 40-75 %[20]. There are 4 subtypes. In the SER1, only the anterior tibiofibular ligament strain occurs. SER 2 is characterized by a short oblique fracture of the fibula in addition to the ATFL injury. SER3 subtype has an additional component of posterior malleoli involvement when compared with SER 2. SER 4 subtype has an associated medial malleoli osteo-ligamentous complex injury.


**PRONATION ABDUCTION**

This fracture occurs when the pronated foot is forcefully abducted, and accounts for 5-21%[21] of the total ankle fractures. The medial malleolus undergoes an avulsion type of fracture and the fibula is fractured at 5-7 cm from the ankle joint. This mechanism poses a threat to the integrity of the syndesmosis and such an injury should be evaluated by stress testing intraoperatively.

## PRONATION EXTERNAL ROTATION

This injury accounts for 19% of all ankle fractures [20]. The fracture begins in the medial side with a transverse fracture of the medial malleolus followed by injury to the ATFL. Then the injury progresses to the lateral side to cause a spiral fracture above the level of syndesmosis, finally causing fracture of the posterior malleoli. It has increased propensity to cause syndesmotic disruption.


The most common mechanism of injury causing syndesmotic diastasis is a combination of **external rotation,**

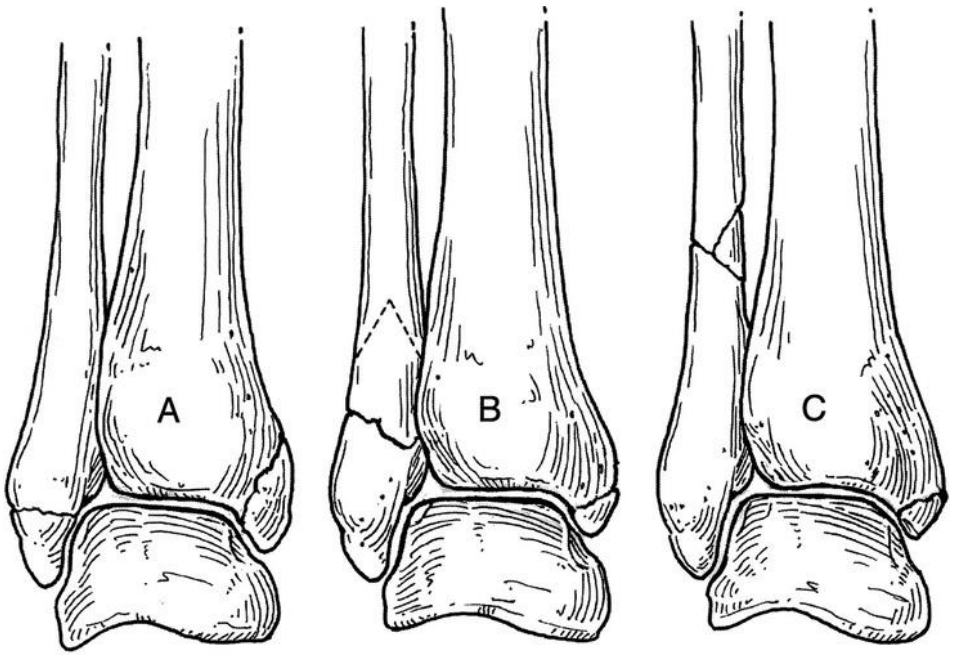
**eversion and dorsiflexion** [22].Syndesmotic injury can occur in the absence of fracture or even with a fracture at the level of syndesmosis).Mechanism of injury of the lateral ankle sprains are a complete opposite where the main mechanism causing injury is plantar flexion and inversion.

# CLASSIFICATION

## DANIS-WEBER CLASSIFICATION

This classification is a simple classification, where the fracture is classified based on the relation of the fracture with the syndesmosis. There are three types of fracture patterns

- Weber A Fracture
- Weber B Fracture
- Weber C Fracture



## Weber A Fracture

This is also called infra-syndesmotic fracture, due to the location of the fracture of the fibula distal to the syndesmosis. It is an avulsion type of injury due to sudden supination of the ankle joint. It can occur as an isolated fibula fracture or an associated vertical medial malleolar fracture can be found.

## Weber B Fracture

This fracture is called the trans-syndesmotic fracture as the fracture occurs at the level of the syndesmosis. The fracture is usually a short oblique fracture which happens due to an external rotation force occurring at the ankle joint. Associated syndesmotic injury is common along with this fracture.

## Weber C Fracture

This fracture is supra-syndesmotic fracture with the fibula fracture occurring above the level of syndesmosis. It is always associated with a syndesmotic instability and a medial malleoli fracture. Pronation abduction or external rotation is the mode of the injury.

# MATERIALS AND METHODS

This study was formally approved by the Ethical committee of Kilpauk Medical College and Hospital and was carried out under their guidance.

This prospective study was carried out at **Department of Orthopaedics , Govt.Kilpauk Medical college and hospital** , Chennai between September 2014- July 2016.

## INCLUSION CRITERIA

A total sample size of 20 patients were included in this study who satisfied the following criterias,

1. Age above 18 years.
2. Skeletally matured.
3. Distal fibula fractures with Weber B and Weber C type of Danis – Weber classification.
4. X-ray suggestive of associated syndesmotic injury.

MRI of the ankle was done wherever possible to diagnose syndesmotic ligament injury and intraoperative stress testing was done to confirm.

All the included patients were duly explained about the procedure and all the treatment options were explained.

**EXCLUSION CRITERIA**

1. Weber A type Fractures
2. Distal fibula fracture without syndesmotic injury.
3. Pediatric and skeletally immature patients
4. Compound injuries
5. Associated neurovascular injuries
6. Pathological fractures
7. Old fractures

All the admitted patients were thoroughly evaluated by doing clinical examination and other injuries were rule out, the distal fibula fracture was initially immobilized by applying a short leg slab and was processed for surgery.

**PRE-OP PLANNING**

**1.** Complete heamogram

**2.** Renal function Test

**3.** Chest x-ray and electrocardiogram

**4.** Bleeding Time and clotting time

All these routine blood investigations were done as a part of the pre-operative planning.

If the patient had any medical comorbidities, they were carefully evaluated and concerned specialist opinion was obtained before taking up for surgery.

**Radiographic evaluation**

The injured ankle was subjected to X-ray evaluation with three views

- X-ray ankle AP view
- X-ray ankle lateral view
- X-ray ankle mortise view

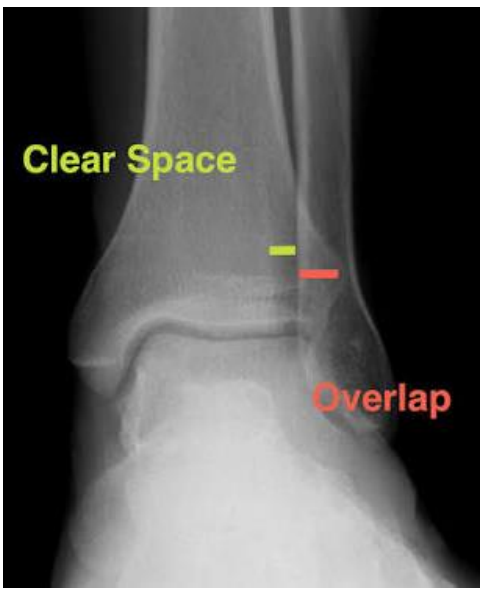
**Syndesmotic injury**

This type of injury can be clinically diagnosed with an associated tenderness along the anterior aspect of the ankle [23].The points to look keenly in the radiographic evaluation of the ankle to diagnose syndesmotic injury

- Increased Tibio-fibular Clear space
- Decreased Tibio-fibular Overlap
- Increased medial clear space

| | |
|---|---|
| Tibio-fibular clear space | <6mm in Both AP and Mortise views |
| Tibio-fibular overlap | >6mm in AP view & >1cm in mortise view |
| Medial clear space | Equal or < superior clear space between talar dome and tibial plafond |

The tibio fibular clear space is measured between the lines A and B as shown in the image and the Tibio-fibular Overlap is measured between the lines B and C as shown in the figure.

Other investigations that can be done are Ultrasonogram, CT and MRI.The syndesmosis being a superficial ligament can be identified by USG but it is not that sensitive and specific. CT can also detect syndesmotic diastasis only on the basis of bony landmarks. MRI is the most sensitive and specific investigation of choice to detect a syndesmotic injury [23].

All the patients in this study were subjected to routine X-ray views and MRI was done as a supportive evidence when and where required. Axial cuts of the syndesmotic area helped in determining the individual ligament injuries.

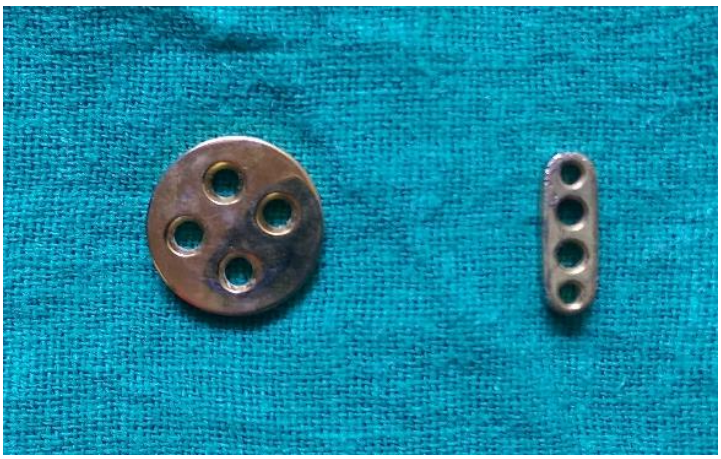
After the cases were diagnosed to have distal fibula fracture with syndesmotic injury, patients were explained regarding various surgical treatment options available for such an injury. Complications were explained of all the treatment options. With proper consent, patients involved in this study were posted for surgery with distal fibula locking compression plate and syndesmotic suture button fixation.

## PRE OP BONE MODEL TRIAL

Initially the suture button technique was attempted in a bone model of tibia and fibula. The suture button consists of three components

- Round button(lateral)
- Oval endobutton(medial)
- Fibre wire(2/5)

5- Fibre wire was chosen because it has got the highest load to failure closely followed by the 2 fibre wire [24].



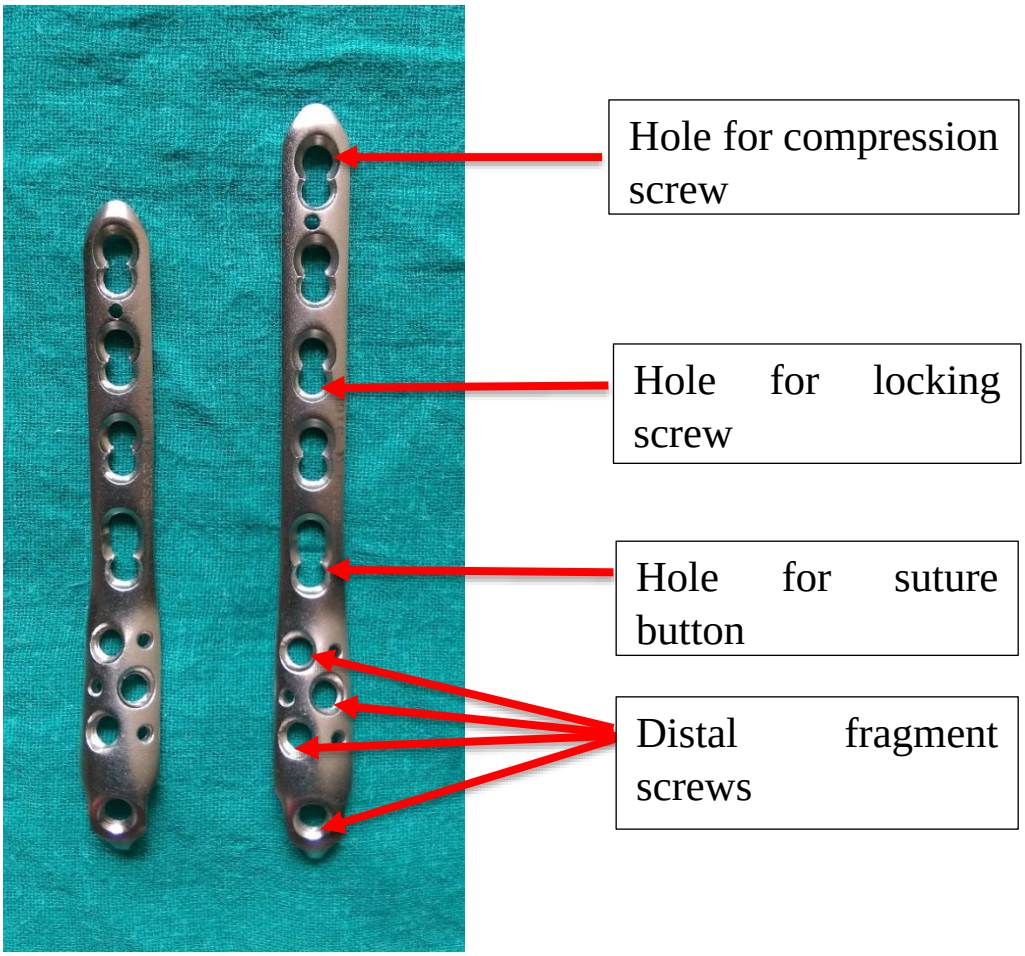
The three components were pre-assembled before each case with sterile precautions. The two buttons were connected by four strands of fibre wire.The free end of the fibre wire was on the lateral side .

The bone model of Tibia and fibula were taken and were held together distally simulating a syndesmotic joint. The drilling was done from the lateral side and four cortices were drilled at a distance of 2 cm from the distal end.

The pre-assembled suture button was attached to an introducer with the help of Vicryl suture material tied to one of the 4 holes of the oval endobutton. The introducer is passed from the lateral side and taken out through the medial side and once the medial button comes out the vicryl is toggled for the medial button to get aligned in a vertical fashion. Then the free ends of the fibre wire on the lateral side are tensioned adequately till the lateral button is apposed to the bone. After adequate tensioning 3-4 knots are applied on the lateral side.

The fibula fracture was fixed by using an anatomically precontoured Locking Compression Plate.

The anatomically preontoured plates are available ranging from 3 holed plate to 10 holed plates and can be used based on fracture pattern. A sleeve is used for applying the locking screws.




The suture button is drilled through the first hole proximal to the distal fragment screws. There are slots for upto 4 screws that can be applied in the distal fragment.

Plate contoured based on the distal fibula anatomy

Distal tip curved to be congruent to fibula and to prevent intraarticular screw penetration

This is the lateral view of the plate, showing adequate precontouring done to match the distal fibula anatomy, hence no contouring or plate bending required intra- operatively.

# SURGICAL INSTRUMENTS

| | |
|---|---|
| 3.2,2.5 mm drill bit | 3.5 mm tap |
| Bone holders | LCP system with sleeve |
| Plate holders | Round lateral button |
| General surgery instruments | Oval medial button |
| Depth gauge | Introducer |

# SURGICAL TECHNIQUE

OPEN REDUCTION WITH INTERNAL FIXATION WITH LCP FOR FIBULA WITH SYNDESMOTIC SUTURE BUTTON FIXATION

After administration of regional anesthesia, the patient was positioned in supine position on a radiolucent table with injured extremity draped  below the knee level.

The C-Arm is draped with a sterile sheet and is positioned perpendicular to the translucent table for further usage.

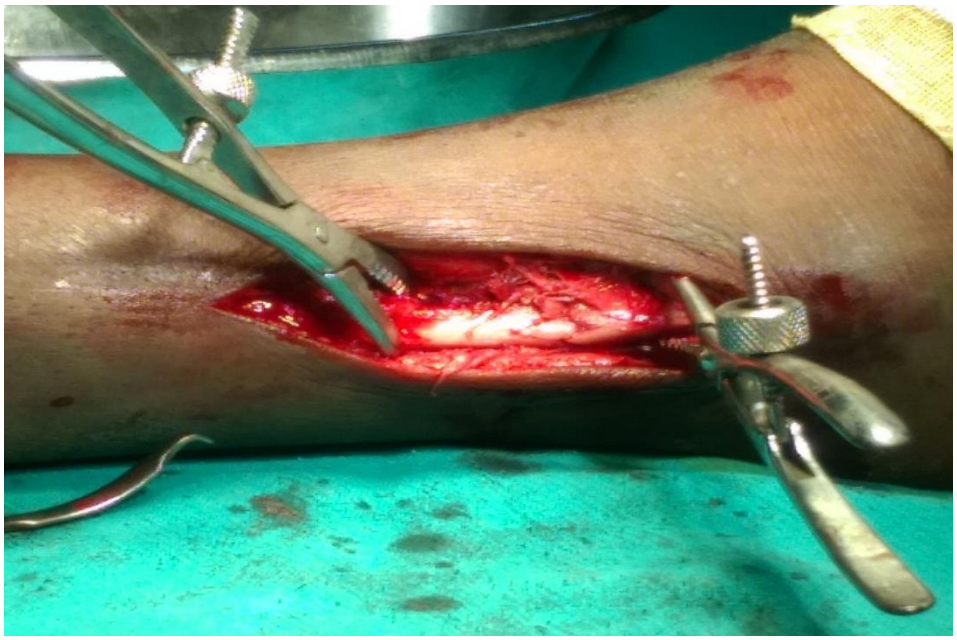
A sand bag is kept below the ipsilateral pelvis for adequate internal rotation of the injured limb facilitating the lateral approach of the fibula.

The longitudinal lateral approach is the standard approach for the distal fibula fractures. The incision is put slightly posterior to the fibula to avoid direct position of the plate beneath the incision.

The superficial tissue is dissected and the approached is deepened between the peroneus tertius and the peroneus longus, brevis.

The fracture edges are freshened and debris are curetted. Excessive periosteum stripping is avoided to prevent devascularisation which will affect fracture healing.

The fracture fragments are held with bone holders.



The anatomical LCP is positioned on the fibula under C-Arm guidance and the bone clamps are applied with suitable reduction.

The distal extent of the plate is visualized under C-Arm.

The first non-locking screw is applied proximally for plate apposition. The other locking screws are applied with sleeve.

The medial side fracture is opened through a medial approach exposing the medial malleoli. The fracture ends are identified and any periosteal interposition is removed and the fracture edges curetted.

The fixation of the medial malleolus, no any single specific fixation was followed and the fixation was done based on the implant availability and the fracture pattern. The fracture was either fixed with tension band wiring, cannulated cancellous screws and in one case K-wire fixation was done.

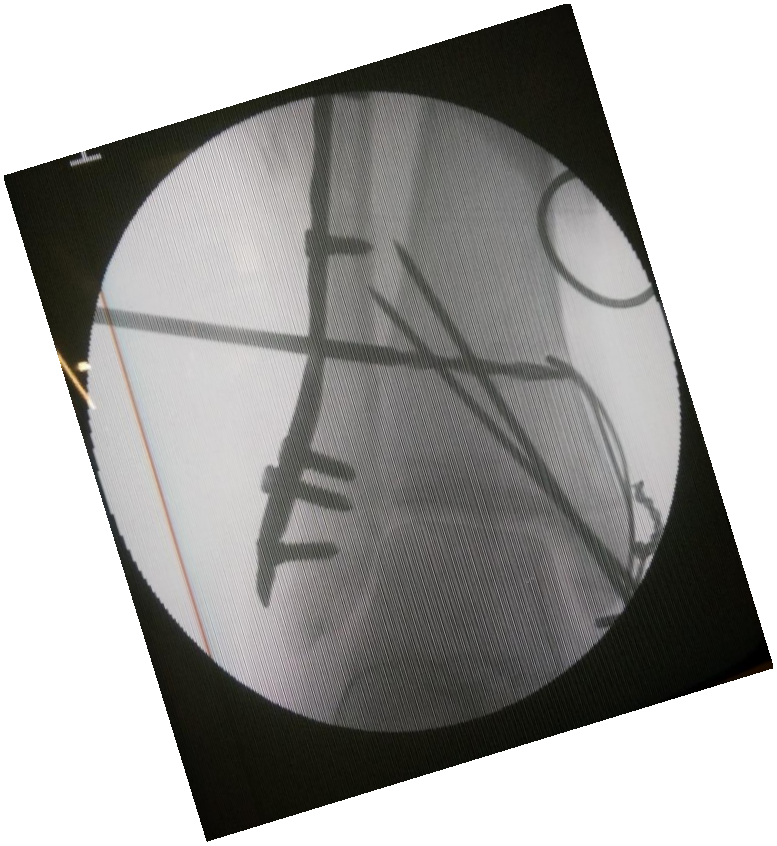
After fixing the bony components both on the lateral and the medial side, the integrity of the Syndesmosis was checked intraoperatively under C-arm guidance.

A bone hook is placed at the level of syndesmosis and a lateral stress is given and checked under C-arm guidance to check the integrity of the syndesmosis.


**Bone hook placed at the level of syndesmosis**


Lateral stress causing displacement of the syndesmosis decreasing the Tibio-fibular overlap.

3.5 mm drill bit is used to drill from the lateral cortex through the first hole of the plate at a distance of 2-2.5 cm from the ankle mortise after suitable reduction of the syndesmosis



- The drill should be parallel to the ankle mortise
- It should be angulated 30 degrees anteriorly
- It is drilled perpendicular to the syndesmotic joint.
- Syndesmosis is held in reduction with a clamp.

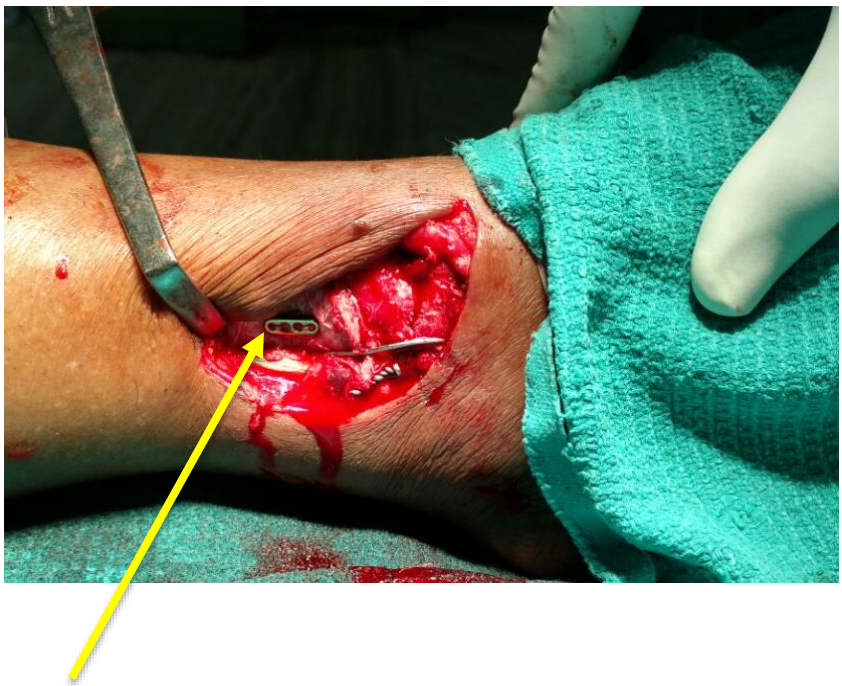
After drilling is completed the preassembled suture button is taken and the vicryl is tied to the two end holes of the oval button and the free ends of the vicryl is tied to the eye in the introducer.

The introducer is passed through the drilled hole created in the first hole of the plate.

In the above picture the introducer is removed from the medial side after passing through the tunnel created in the tibia and fibula.

The introducer can be taken out in the medial side just by the piercing the sharp end and no separate medial incision is required. If the fixation of the medial malleolus fracture demands a bigger incision, the medial button can be manipulated through that incision.

Otherwise the free ends of the vicryl are toggled under the C-arm guidance for the medial button to get aligned in a vertical fashion apposed to the Tibia.



Vertically aligned endobutton

In this case the incision used for the tension band wiring is utilized.

Now the free ends of the fibre wire are present in two holes of the lateral round button.

One assistant gives a mild lateral stress underneath the button while the two free ends are slowly and equally pulled which gradually pushes the button towards the fibula. The lateral button flushes along with the fibular plate. Now the two free ends are adequately pulled and tensioned and 3-4 knots are applied.

The above picture shows the gradual and equal pulling of the two free ends of fibre wire and the round button apposing towards the fibula.

The round button is apposed well to the plate and three knots are applied.

The medial and lateral side are closed in layers and on the lateral side a  suction drain is kept.

**POST – OPERATIVE CARE**

All the patients were advised to keep the limb elevated, intravenous antibiotic cover was provided till 5th day and then it was converted to oral antibiotics. Post-operative x-ray was taken on the next day after surgery.

Check dressing was done on the 2nd and 5th day. Patients were discharged after 5 th post-operative day and sutures were removed on the 12 th post-operative day.

Strict non- weight bearing was advised for the patients. Assisted ankle mobilization was initiated .Check x-ray was taken at 6 weeks.

Partial weight bearing was advised with support by 8 weeks. After confirming consolidation and radiological signs of union, full weight bearing was initiated from 12th week onwards.

| | |
|---|---|
| IV antibiotics | 5th post-operative day |
| Suture removal | 12th post-operative day |
| Assisted ankle mobilisation | From 1st week |
| Partial weight bearing | From 6 weeks |
| Full weight bearing | From 12 weeks |

## OUTCOME ASSESSMENT

Functional outcome was done using the American Orthopaedic Foot and Ankle Society (AOFAS) – Ankle and hind foot scale scoring system.

Radiological outcome was observed based on the appearance of bridging callus and fracture line consolidation in successive follow up x-rays.

Clinical outcome was observed based on the absence of tenderness. Secondary outcomes were measured based on the perioperative data like duration of the surgery , amount of blood loss, length of the incision and complications like neurovascular injury , non-union , malunion , implant failure , infection .

## AOFAS SCORE – ANKLE & HINDFOOT SCALE

*Pain (40 points)*

- None.....40
- Mild, occasional.....30
- Moderate, daily.....20
- Severe, almost always present.....0

*Function (50 points)*

Activity limitations, support requirement

- No limitations, no support.....10
- No limitation of daily activities, limitation of recreational activities, no support...7
- Limited daily and recreational activities, cane.....4
- Severe limitation of daily and recreational activities, walker, crutches, wheelchair, brace.....0

Maximum walking distance, blocks

- Greater than 6.....5
- 4-6.....4
- 1-3.....2
- Less than 1.....0

Walking surfaces

- No difficulty on any surface.....5
- Some difficulty on uneven terrain, stairs, inclines, ladders..... 3
- Severe difficulty on uneven terrain, stairs, inclines, ladders..... 0

Gait abnormality

- None, slight.....8
- Obvious.....4
- Marked.....0

Sagittal motion (flexion plus extension)

- Normal or mild restriction (30° or more).....8
- Moderate restriction (15°-29°).....4
- Severe restriction (less than 150).....0

Hindfoot motion (inversion plus eversion)

- Normal or mild restriction (75%-100% normal).....6
- Moderate restriction (25%-74% normal).....3
- Marked restriction (less than 25% normal).....0

Ankle-hindfoot stability (anteroposterior, Varus-valgus)

- Stable.....8
- Definitely unstable.....0

*Alignment (10 points)*

- Good, plantigrade foot, midfoot well aligned.....15
- Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms.....8
- Poor, nonplantigrade foot, severe malalignment, symptoms.....0

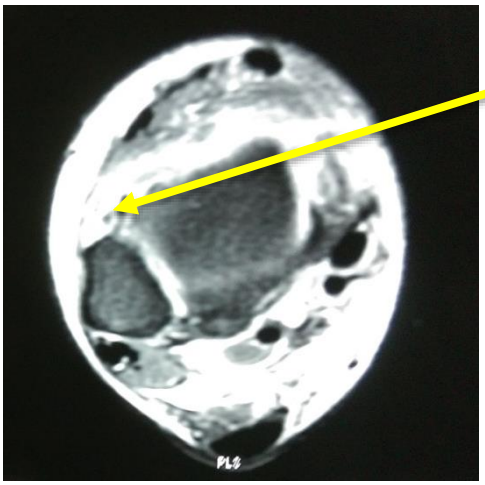
This scoring system is applied for all the patients and all the parameters were individually observed and the scores noted and added up for all the patients. The total score of this scale is 100.

After measuring the individual parameters, they are summed up and tabulated for all the cases. Based on the scores the outcome is decided.

| **Score** | **Outcome** |
|---|---|
| >90 | Excellent |
| 81-90 | Good |
| <80 | Fair |

# CASE REPORTS

## CASE 1



Tear noted in the ATFL in Axial cuts

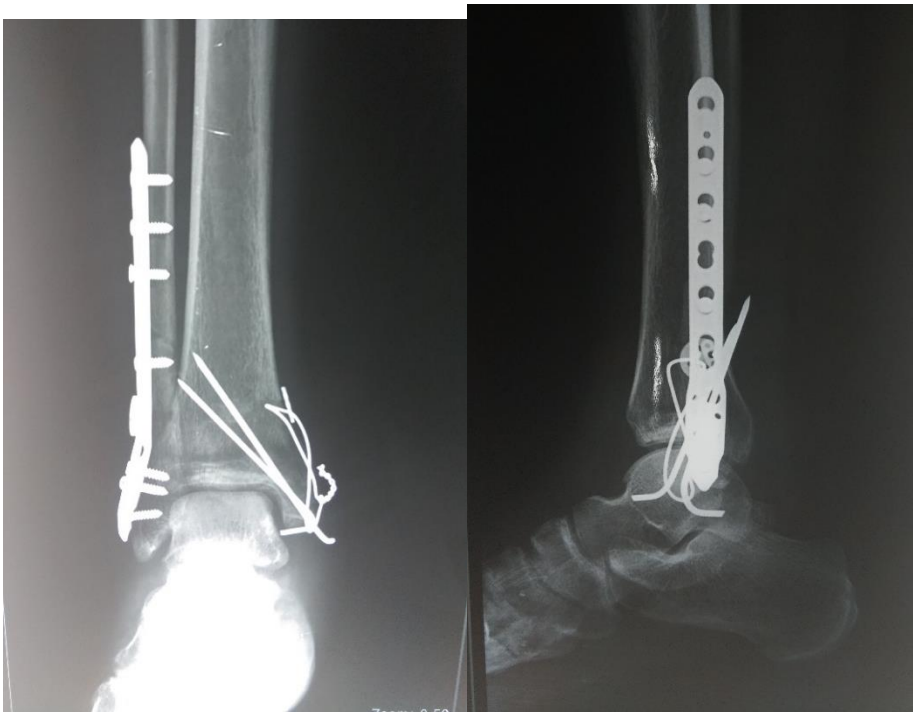
## IMMEDIATE POST OP XRAY


MORTISE View Lateral View

## 6 WEEKS FOLLOW UP

AP VIEW LATERAL VIEW

## 3 MONTHS FOLLOW UP



Mortise View Lateral View

## 6 MONTHS FOLLOW UP

AP VIEW LATERAL VIEW

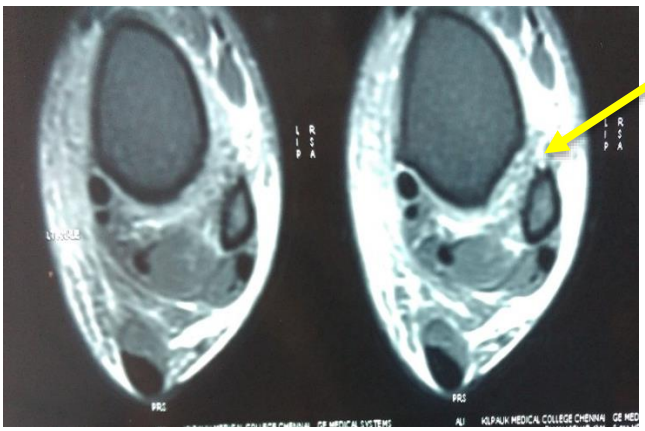
# CLINICAL PHOTO

# CASE NO 2

## PRE OP XRAYS

MORTISE AP LATERAL

## PRE OP MRI:



RUPTURE OF ATFL

## IMMEDIATE POST OP XRAY

MORTISE LATERAL

## 6 WEEKS FOLLOW UP:

AP VIEW LATERAL VIEW

## 6 MONTHS FOLLOW UP


MORTISE LATERAL

## CLINICAL PHOTO

# CASE NO 3:

## PRE OP XRAYS

## IMMEDIATE POST OP

AP LATERAL

## 6 WEEKS FOLLOW UP

AP LATERAL

## 3 MONTHS FOLLOW UP


MORTISE AP LATERAL

## 6 MONTHS FOLLOW UP

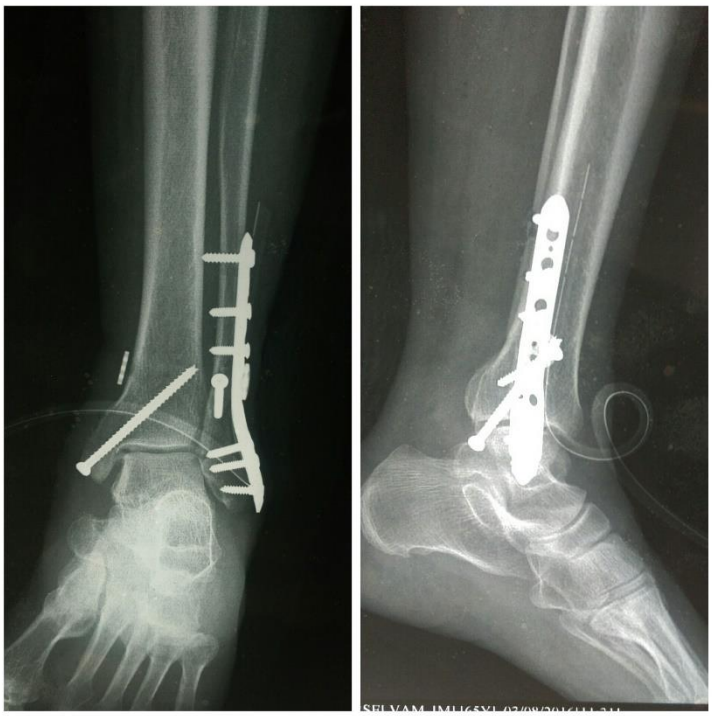
MORTISE AP LATERAL

CLINICAL PHOTO

# CASE NO 4

## PRE OP XRAYS

## IMMEDIATE POST OP



AP LATERAL

## 6 WEEKS FOLLOW UP

AP LATERAL

## 3 MONTHS FOLLOW UP

AP VIEW LATERAL VIEW

## 6 MONTHS FOLLOW UP

MORTISE AP LATERAL

## CLINICAL PHOTO

# COMPLICATIONS

One case underwent similar fixation of the distal fibula and syndesmotic fixation. The patient was having uncontrolled diabetes mellitus and did not come for periodic follow up as advised.

Patient developed superficial infection for which culture specific antibiotics were given, and infection controlled after 2 months. He had repetitive infection in surgical scar site followed by a formation of a sinus which was controlled by antibiotics alone.Implant exit was done finally.

Patient did not have any functional limitations and was able to do his day to day activities without any hindrance. At the end of 6 months his AOFAS score was 82. This was the lowest score observed in our study.

# X-RAYS

Pre op x-ray Immediate Post-op

6 months post op

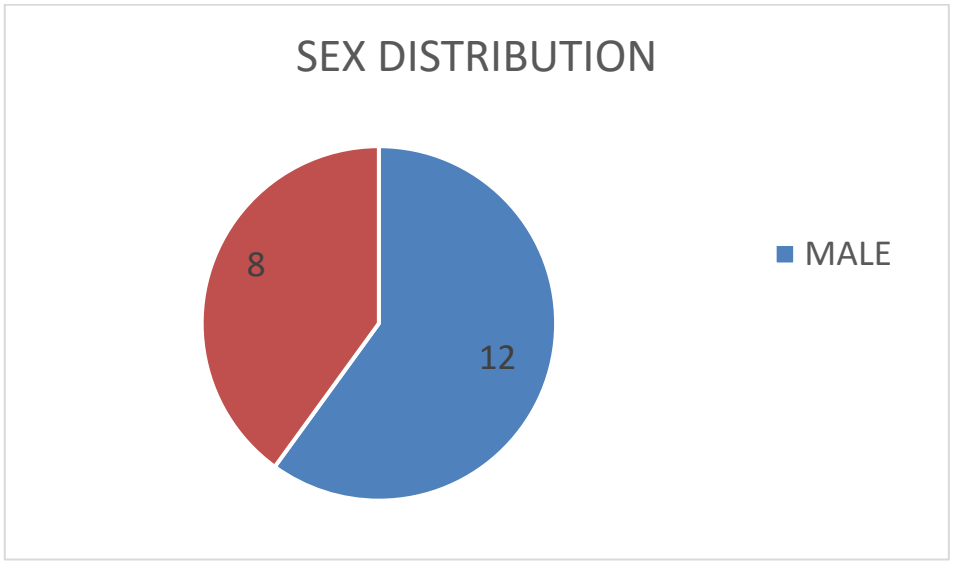
**Sinus formation in the surgical scar.**

8 months post op, after confirming radiological and clinical union, implant exit was done for the patient. Following which the wound got settled and the patient is functionally doing well.

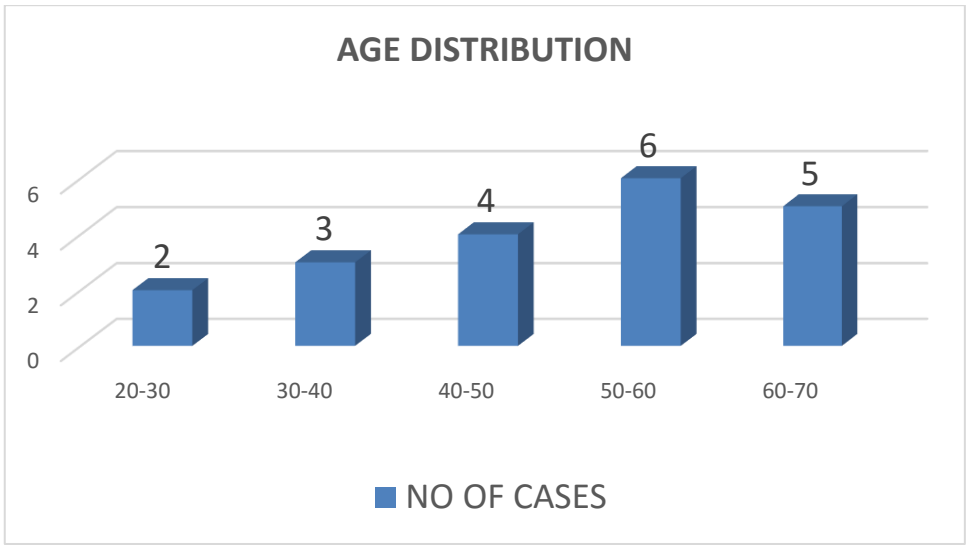
No complications were observed in other cases.

# OBSERVATION

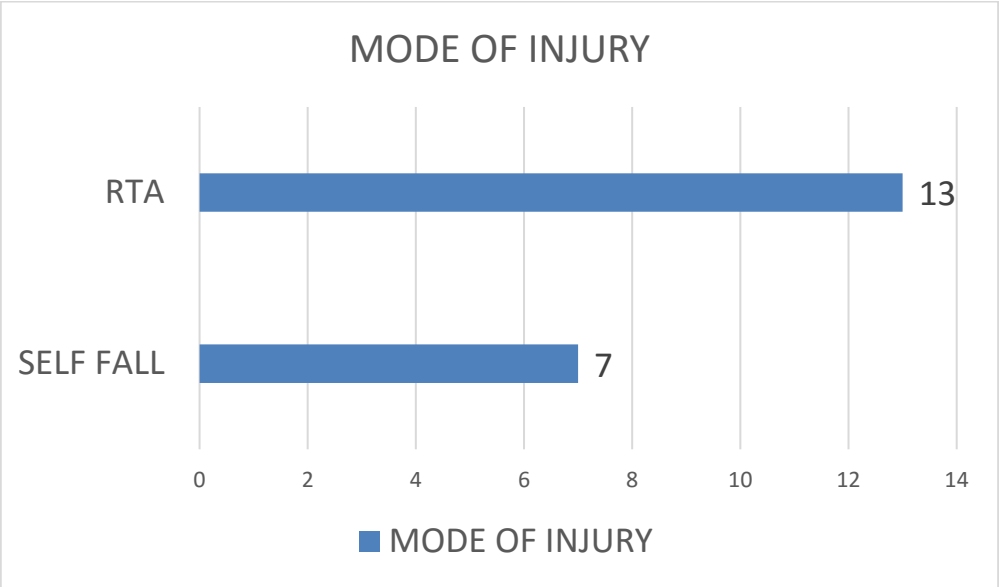
The patient demographics involved in this study is as follows.




## AGE DISTRIBUTION



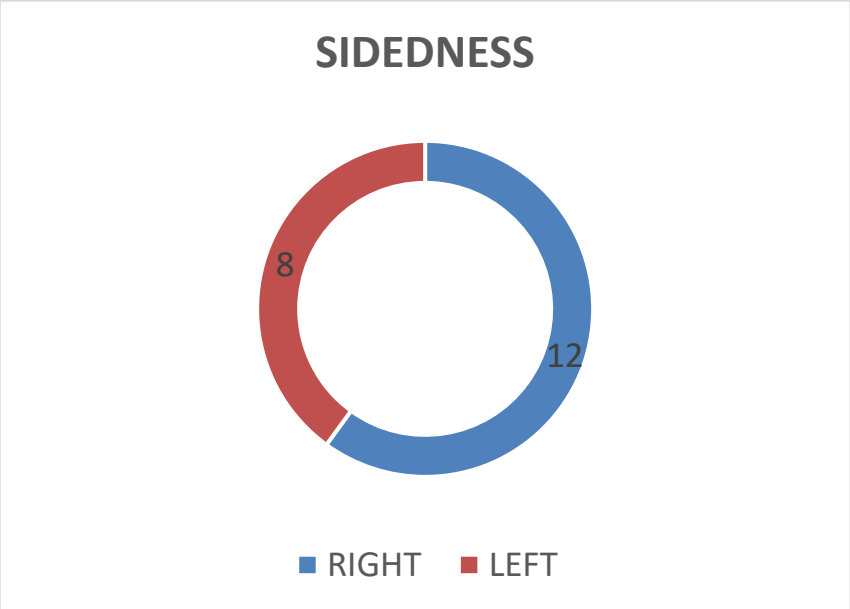
## MODE OF INJURY




The commonest mode of injury was road traffic accidents.

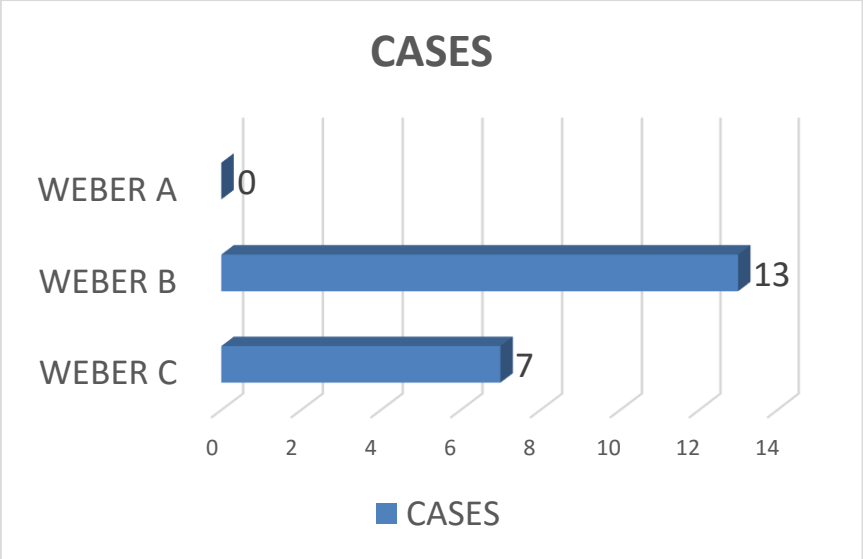
## SIDEDNESS OF THE INJURY

Right side was the commonly involved



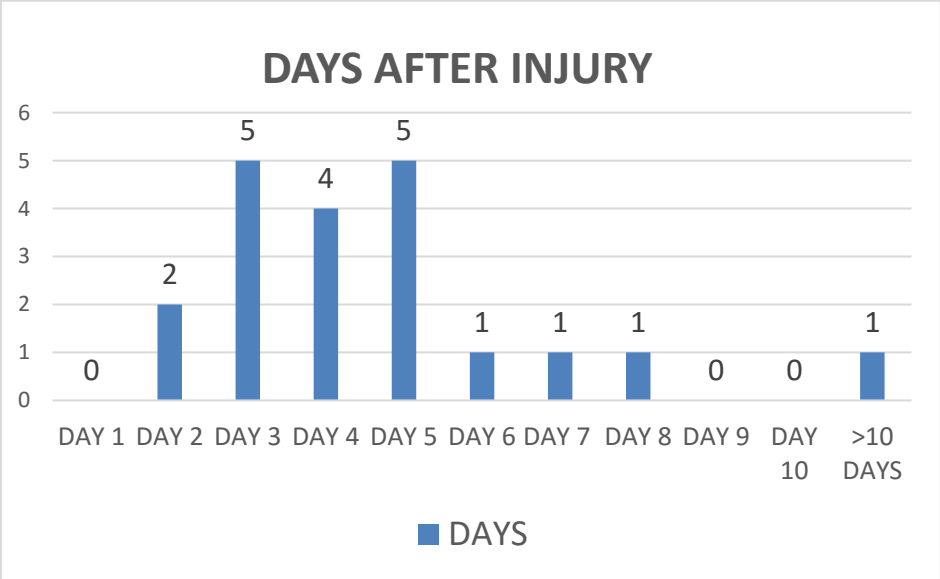
## CLASSIFICATION

The classification system followed in this study is Weber classification. The commonest fracture pattern was Weber Type B fracture followed by Weber Type C fracture.



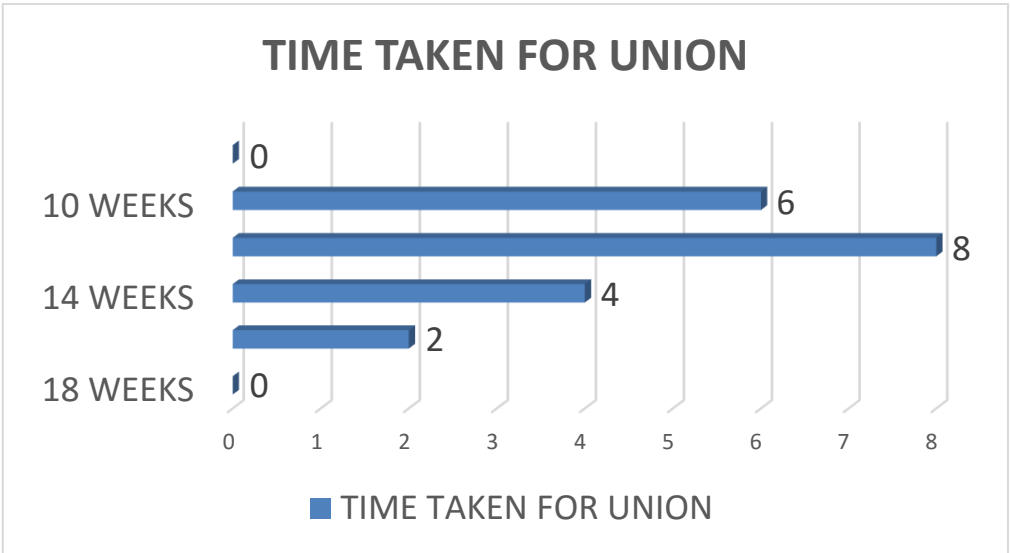

Out of the 20 cases, 18 cases had associated medial malleolus fracture of various patterns that was surgically fixed based on the fracture pattern, one case had a distal tibia fracture and one case had no other fractures

## TIMING OF SURGERY



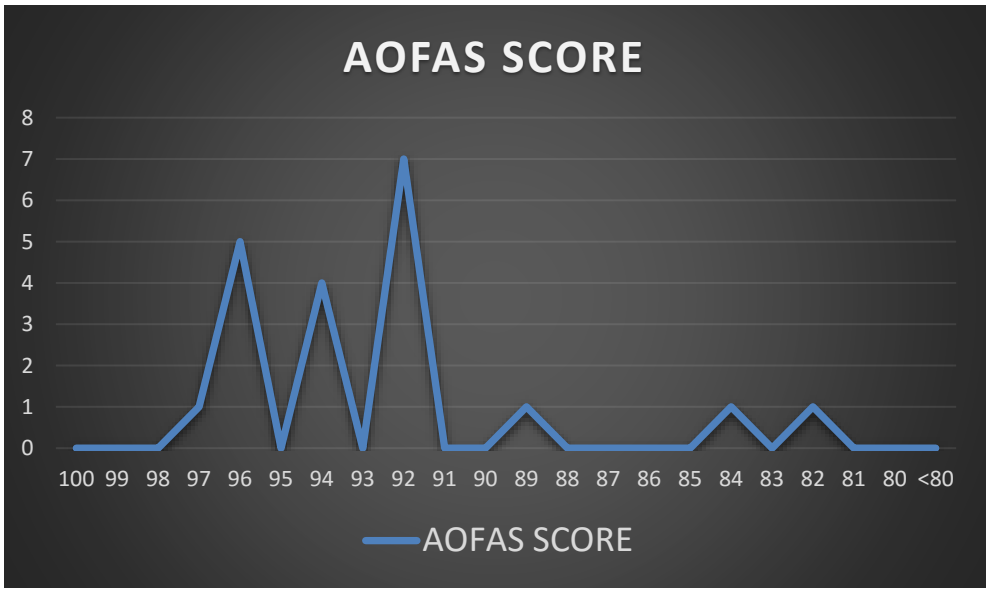

Almost all the cases were taken up for surgery before the 5$^{th}$ day except in few cases where the patient's general condition had to be stabilized to get anaesthetic fitness. One of the patients presented only after 10 days of trauma.

## TIME TAKEN FOR UNION



In these 20 cases , the average time taken for union was observed to be 12.1 weeks with a standard deviation of 1.72. Almost 14 of the total cases were able to return to their daily routine at the end of three months without any pain.

**AOFAS SCORING**




The AOFAS scoring was done individually for all cases and were recorded at the end of 6 months since surgery. From the graph it is evident that a cluster of 17 cases had a score more than 90 which indicates an excellent outcome.

The average AOFAS score is 92.6 with a standard deviation of 3.667.

# RESULTS

EVALUATION OF PAIN

| PAIN SCALE | SCORE | NO OF CASES | |
|---|---|---|---|
| | | 3 MONTHS | 6 MONTHS |
| NO PAIN | 40 | 13(65%) | 17(85%) |
| MILD,OCCASIONAL | 30 | 7(35%) | 3(15%) |
| MODERATE,DAILY | 20 | 0 | 0 |
| SEVERE,ALWAYS PRESENT | 0 | 0 | 0 |

All the patients at the end of 6 months were comfortable to do their day to day activities without any pain. Only three patients had occasional pain on doing strenuous activities. On an average 65% of the patients were able to do pain free activities as early as 12 weeks, while other patients were also able to do similarly at the end of 6 months.

**RANGE OF MOTION**

| SERIAL NO | MOVEMENTS | AVERAGE(MEAN PLUS SD) |
|---|---|---|
| 1 | DORSIFLEXION | 17±1.788 |
| 2 | PLANTARFLEXION | 30.5±1.466 |
| 3 | INVERSION | 16.25±1.089 |
| 4 | EVERSION | 16.45±0.920 |

At the end of 6 months all the patients had a normal range of movements, able to do their day to day activities. There was no stiffness or restriction of movements as mobilization was started early and physiotherapy was given adequately.

# FUNCTIONAL OUTCOME

| S .NO | RESULT | SCORE | CASES | PERCENTAGE |
|---|---|---|---|---|
| 1 | EXCELLENT | >90 | 17 | 85% |
| 2 | GOOD | 81-90 | 3 | 15% |
| 3 | FAIR | 60-79 | 0 | 0% |
| 4 | POOR | <60 | 0 | 0% |

- **17 Cases (85%) had an excellent outcome.**
- **3 cases(15%) had a good outcome**

# STATISTICS

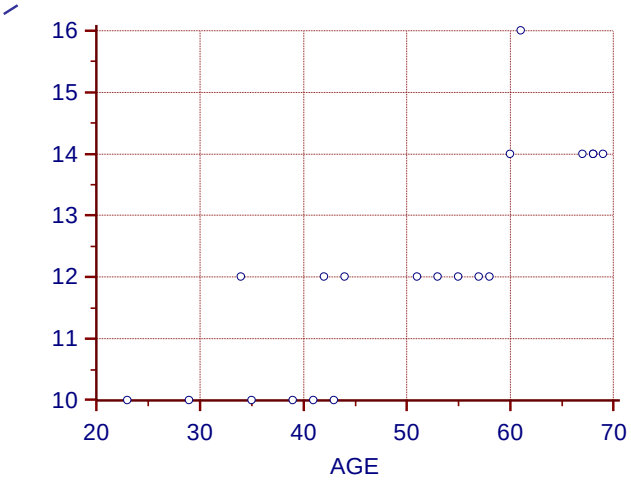
## 1. AGE VS TIME FOR UNION IN WEEKS

| | | | | | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound |
| up to 40 years | 5 | 10.40 | .894 | .400 | 9.29 | 11.51 |
| 41-60 years | 10 | 11.80 | 1.135 | .359 | 10.99 | 12.61 |
| 61 years & above | 5 | 14.40 | .894 | .400 | 13.29 | 15.51 |
| Total | 20 | 12.10 | 1.774 | .397 | 11.27 | 12.93 |

TIME FOR UNION IN WEEKS

| | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 41.800 | 2 | 20.900 | 19.739 | **.000** |
| Within Groups | 18.000 | 17 | 1.059 | | |
| Total | 59.800 | 19 | | | |

**There is a statistically significant correlation between age of the age patient and the time taken for union.**




**Scatter diagram**

## Correlation

| | |
|---|---|
| Variable Y | TIME_FOR_UNION_IN_WEEKS<br>TIME FOR UNION IN WEEKS |
| Variable X | AGE |

| | |
|---|---|
| Sample size | 20 |
| Correlation coefficient r | 0.8290 |
| Significance level | P<0.0001 |
| 95% Confidence interval for r | 0.6105 to 0.9303 |

## Regression

| | |
|---|---|
| Dependent Y | TIME_FOR_UNION_IN_WEEKS<br>TIME FOR UNION IN WEEKS |
| Independent X | AGE |

**There exists a positive regression between age and time for union**

## 2. AGE vs AOFAS SCORE

AOFAS SCORE

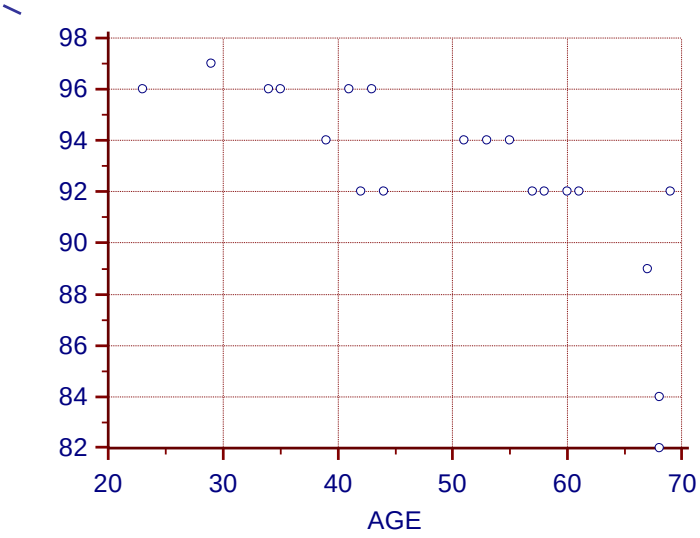
| | | | | | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound |
| up to 40 years | 5 | 95.80 | 1.095 | .490 | 94.44 | 97.16 |
| 41-60 years | 10 | 93.40 | 1.647 | .521 | 92.22 | 94.58 |
| 61 years & above | 5 | 87.80 | 4.604 | 2.059 | 82.08 | 93.52 |
| Total | 20 | 92.60 | 3.885 | .869 | 90.78 | 94.42 |

**ANOVA**

AOFAS SCORE

| | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 172.800 | 2 | 86.400 | 12.884 | **.000** |
| Within Groups | 114.000 | 17 | 6.706 | | |
| Total | 286.800 | 19 | | | |

**There is a statistically significant correlation between Age and the AOFAS score**




**Correlation**

| | |
|---|---|
| Variable Y | AOFAS_SCORE<br>AOFAS SCORE |
| Variable X | AGE |

| | |
|---|---|
| Sample size | 20 |
| Correlation coefficient r | -0.7587 |
| Significance level | P=0.0001 |
| 95% Confidence interval for r | -0.8993 to -0.4759 |

**Regression**

| | |
|---|---|
| Dependent Y | AOFAS_SCORE<br>AOFAS SCORE |
| Independent X | AGE |

| | |
|---|---|
| Sample size | 20 |
| Coefficient of determination $R^2$ | 0.5756 |
| Residual standard deviation | 2.6005 |

**Scatter diagram indicates negative regression between age and AOFAS score. Greater the age lesser the score**

## 3. WEBER TYPE FRACTURE VS AOFAS SCORE

| | | | | | 95% Confidence Interval for Mean | |
|---|---|---|---|---|---|---|
| | N | Mean | Std. Deviation | Std. Error | Lower Bound | Upper Bound |
| 2 | 13 | 91.77 | 4.400 | 1.220 | 89.11 | 94.43 |
| 3 | 7 | 94.14 | 2.193 | .829 | 92.11 | 96.17 |
| Total | 20 | 92.60 | 3.885 | .869 | 90.78 | 94.42 |

AOFAS SCORE

| | Sum of Squares | Df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 25.635 | 1 | 25.635 | 1.767 | **.200** |
| Within Groups | 261.165 | 18 | 14.509 | | |
| Total | 286.800 | 19 | | | |

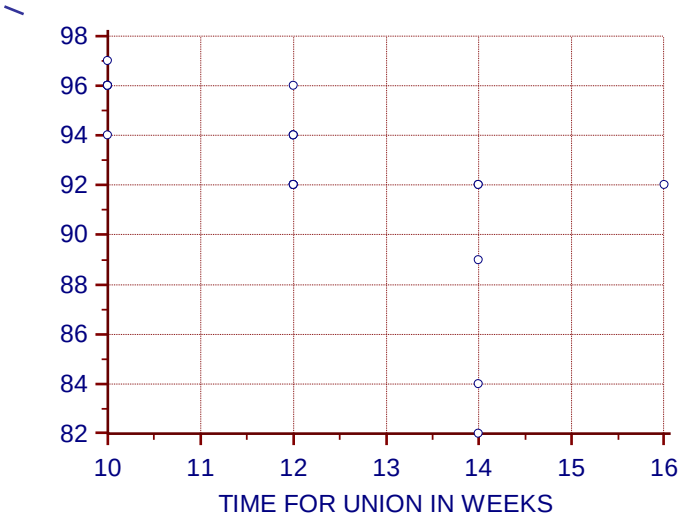
There is **no statistical significance** between Weber type fracture and AOFAS score

## 4. TIME FOR UNION VS AOFAS SCORE

## Correlation

| | |
|---|---|
| Variable Y | AOFAS_SCORE<br>AOFAS SCORE |
| Variable X | TIME_FOR_UNION_IN_WEEKS<br>TIME FOR UNION IN WEEKS |

| | |
|---|---|
| Sample size | 20 |
| Correlation coefficient r | -0.6811 |
| Significance level | **P=0.0009** |
| 95% Confidence interval for r | -0.8634 to -0.3415 |




**There is a statistically significant correlation between Time for union and AOFAS score. Earlier the union better the AOFAS scores.**

# DISCUSSION

The important aspect of using a locking compression plate is the ability to use two different anchorage technologies by using a single implant. The LCP can be used either as a locked internal fixator or simply as a compression plate based on the patients requirement.

Conventionally bicortical fixation of the distal fibula has got three times the pull out strength when compared to unicortical purchase. Due to anatomical constraints the fixation of the distal periarticular region of the fibula should be restricted to unicortical screw application . When using conventional plating, such a unicortical fixation in the distal fragment will lead to increased rates of implant failure. When compared to the conventional plating techniques the use of LCP is independent of the bone mineral density status [5, 6].

Similar to external fixator, the LCP can function as a fixed angle construct. The fixed angle construct obviates the need of having compression effect between the plate and the bone. It

also prevents toggling and screw back out happening due to micro motion, osteopenia induced by stress shielding effect.

One of the major concern in using a LCP for distal fibula fracture is the hardware prominence on the lateral side and chance of wound gaping and infection. Decreased operative time, adequate soft tissue cover with proper skin closure, providing adequate antibiotic cover, limb elevation and anti-edema measures post operatively has helped better in preventing wound related complications.

Studies have clearly shown that syndesmosis functions in a dynamic fashion during normal ankle motion. During motion fibula descends distally, laterally with a rotational component. This has led to the fixation of syndesmotic injuries which maintains the dynamic properties of the joint.

The ideal implant to be used for syndesmotic injuries should prevent late diastasis and help in early return to activity. The need for implant removal, chances of screw breakage and related complications can be avoided by using the suture button as the fixation device

The application of the suture button is an easy procedure without any technical difficulties and no additional special device is required except an introducer. The suture is unlikely to fatigue easily, hence implant removal is routinely not required. The patients can begin their rehabilitational activities at an earlier stage as the suture device exactly simulates the role carried out by the ligaments.

# SUMMARY

At the end of the study we had 20 cases in the follow up stage out of which 12 were male and 8 were females. The average age of the cases was 49.5 years ranging between 23-68 years.

The mean of the time taken before surgery was 4.77 days (range 2-14 days).

The commonest fracture pattern was that of Weber type B with 13 cases with the remaining 7 cases being Weber type C fractures.

The most common associated fracture was a medial malleolus fracture in 18 cases of various patterns, one case had an associated distal fibula fracture and on case had an isolated fibula fracture alone.

All the cases achieved radiological union and resumes their activities at an average of 12.1 weeks with a range between 10-16 weeks.

The average AOFAS score was found to be 92.6 with scores ranging from 82-97.

17 cases had excellent outcome and 3 cases had good outcome.

No routine removal was done for any of the cases, none of the cases had any intraoperative complications during the procedure.

One of the patient postoperatively developed a superficial skin infection due to poor hygiene which was controlled by good wound care and intravenous antibiotic cover. However the patient due to poor hygiene and uncontrolled diabetes mellitus repeatedly got superficial infection and finally implant removal was done for the patient after signs of radiological union was observed.

However that patient did not have any functional disability. He did not have any disabling pain and was able to do his day to day activities with mild discomfort. He was able to achieve an AOFAS score of 82.

No other major complications were observed itntra-operatively and post- operatively. No case was reported to have any activity restriction or a fair or poor outcome.

None of the cases were reported to have any neurovascular complications, non-union, malunion and implant failure.

# CONCLUSION

The fixation of distal fibula fractures with syndesmotic injury with anatomical Locking compression plate and syndesmotic suture button fixation is an effective method of fixation in view of,

- Excellent fracture union
- Early rehabilitation
- Better fixation in comminuted and small distal fragment.
- Better fixation in osteoporotic bones
- Improved ankle stability
- Avoidance of syndesmotic screw related complications
- Lesser morbidity
- Fewer complications

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# MASTER CHART

| S NO | AGE | SEX | MODE OF INJURY | SIDE | WEBER TYPE | OTHER FRACTURES | COMPOUND INJURY | COMORBITIES | ANKLE SUBLUXATION |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 29 | M | 1 | 1 | 3 | 2 | NO | 1 | NO |
| 2 | 35 | M | 1 | 2 | 2 | 2 | NO | 1 | NO |
| 3 | 68 | M | 2 | 2 | 2 | 2 | NO | 2 | NO |
| 4 | 67 | M | 2 | 1 | 2 | 1 | NO | 2 | NO |
| 5 | 43 | M | 1 | 1 | 3 | 2 | NO | 1 | NO |
| 6 | 55 | F | 1 | 1 | 2 | 2 | NO | 1 | NO |
| 7 | 60 | M | 2 | 2 | 2 | 2 | NO | 2 | NO |
| 8 | 58 | F | 2 | 2 | 2 | 2 | NO | 1 | YES |
| 9 | 53 | F | 1 | 2 | 2 | 2 | NO | 2 | YES |
| 10 | 23 | M | 1 | 1 | 2 | 3 | NO | 1 | NO |
| 11 | 44 | M | 1 | 1 | 3 | 2 | NO | 2 | YES |
| 12 | 39 | M | 1 | 2 | 2 | 2 | NO | 1 | YES |
| 13 | 41 | M | 1 | 1 | 3 | 2 | NO | 3 | NO |
| 14 | 69 | F | 1 | 1 | 2 | 2 | NO | 2 | NO |
| 15 | 34 | F | 1 | 2 | 2 | 2 | NO | 1 | NO |
| 16 | 51 | M | 2 | 1 | 3 | 2 | NO | 2 | NO |
| 17 | 57 | F | 1 | 1 | 3 | 2 | NO | 1 | YES |
| 18 | 61 | F | 2 | 2 | 2 | 2 | NO | 3 | NO |
| 19 | 68 | F | 1 | 1 | 2 | 2 | NO | 2 | NO |
| 20 | 42 | M | 2 | 1 | 3 | 2 | NO | 3 | YES |

- **Mode of injury** : 1- RTA , 2-Self fall
- **Side** : 1 – Right , 2- Left
- **Other Fractures** : 1- Nil , 2- Medial malleoli Fracture, 3-Distal tibia Fracture
- **Comorbidities** :1-Nil , 2-Diabetes Mellitus, 3- Hypertension

| CASE | DAYS BEFORE SURGERY | FOLLOW UP IN MONTHS | TIME FOR UNION IN WEEKS | ANKLE DF | ANKLE PF | INVERSION | EVERSION | AOFAS SCORE | COMPLICATION | RESULT |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3 | 13 | 10 | 20 | 32 | 17 | 17 | 97 | NO | EXCELLENT |
| 2 | 2 | 12 | 10 | 20 | 31 | 16 | 17 | 96 | NO | EXCELLENT |
| 3 | 7 | 10 | 14 | 15 | 28 | 14 | 15 | 82 | YES | GOOD |
| 4 | 14 | 10 | 14 | 14 | 27 | 14 | 14 | 89 | YES | GOOD |
| 5 | 3 | 9 | 10 | 20 | 32 | 17 | 17 | 96 | NO | EXCELLENT |
| 6 | 5 | 8 | 12 | 18 | 31 | 16 | 16 | 94 | NO | EXCELLENT |
| 7 | 8 | 7 | 14 | 18 | 31 | 16 | 17 | 92 | NO | EXCELLENT |
| 8 | 4 | 7 | 12 | 16 | 30 | 15 | 16 | 92 | NO | EXCELLENT |
| 9 | 3 | 6 | 12 | 16 | 30 | 17 | 16 | 94 | NO | EXCELLENT |
| 10 | 2 | 11 | 10 | 18 | 32 | 18 | 18 | 96 | NO | EXCELLENT |
| 11 | 5 | 10 | 12 | 17 | 30 | 16 | 17 | 92 | NO | EXCELLENT |
| 12 | 3 | 6 | 10 | 18 | 32 | 17 | 16 | 94 | NO | EXCELLENT |
| 13 | 5 | 9 | 10 | 18 | 32 | 17 | 17 | 96 | NO | EXCELLENT |
| 14 | 4 | 8 | 14 | 16 | 30 | 16 | 16 | 92 | NO | EXCELLENT |
| 15 | 3 | 10 | 12 | 17 | 32 | 17 | 18 | 96 | NO | EXCELLENT |
| 16 | 5 | 7 | 12 | 18 | 32 | 18 | 17 | 94 | NO | EXCELLENT |
| 17 | 6 | 9 | 12 | 16 | 30 | 16 | 16 | 92 | NO | EXCELLENT |
| 18 | 5 | 6 | 16 | 15 | 30 | 15 | 16 | 92 | NO | EXCELLENT |
| 19 | 4 | 10 | 14 | 14 | 28 | 16 | 16 | 84 | NO | GOOD |
| 20 | 4 | 7 | 12 | 16 | 30 | 17 | 17 | 92 | NO | EXCELLENT |

# PROFORMA

Name:

Age / Sex:

IP number:

Address:

Contact Number:

Date of Admission:

Date of Surgery:

Date of Discharge:

Occupation:

Education:

Socioeconomic Status:

Diagnosis:

**HISTORY:**

1. Mode of injury: Road traffic accident / fall at home / fall from Height / Assault

2. Presenting complaints:

a. Pain – site / duration

b. Swelling – site / extent

c. Deformity

d. Disturbances in function – movements

e. Other associated injuries – head injury / limb injuries / spine Injuries

3. Comorbid illnesses:

- Diabetes mellitus
- Hypertension

- Coronary heart disease
- Renal disorder
- Seizures
- Bronchial Asthma
- Chronic Obstructive lung diseases
- Neoplastic disorders

4. Drug history: Steroids / Disease modifying anti-rheumatoid drugs / Immunosuppressant

PAST HISTORY:

- Any similar injuries
- Previous surgeries or hospitalisations
- Any major illnesses

PERSONAL HISTORY:

TREATMENT HISTORY:

FAMILY HISTORY:

**CLINICAL EXAMINATION:**

GENERAL EXAMINATION:

- Appearance and built
- Pallor
- Icterus
- Cyanosis

- Clubbing
- Lymphadenopathy
- Pedal edema

VITALS:

1. Pulse:
2. BP:
3. Respiratory rate:
4. Temperature:

SYSTEMIC EXAMINATION:

- Cardiovascular system :
- Respiratory system :
- Abdomen :

REGIONAL EXAMINATION

RIGHT / LEFT ANKLE

OTHER INJURIES

X – RAY FINDINGS:

FINAL DIAGNOSIS:

INITIAL TREATMENT GIVEN:

TIME INTERVAL BETWEEN INJURY AND SURGERY:

PROCEDURE DONE:

MOBILIZATION STARTED ON:

COMPLICATIONS:

POST OP PERIOD:

| | | | |
|---|---|---|---|
| 1ST WEEK | | | |
| 6TH WEEK | | | |
| 3 MONTHS | | | |
| 6 MONTHS | | | |

FOLLOW UP PERIOD:

CONSTANT SCORE:

**FUNCTIONAL OUTCOME:**

# CONSENT FORM

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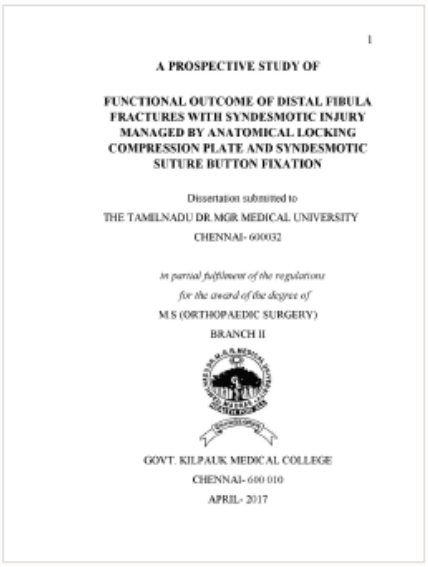

1

**A PROSPECTIVE STUDY OF**

**FUNCTIONAL OUTCOME OF DISTAL FIBULA FRACTURES WITH SYNDESMOTIC INJURY MANAGED BY ANATOMICAL LOCKING COMPRESSION PLATE AND SYNDESMOTIC SUTURE BUTTON FIXATION**

Dissertation submitted to
THE TAMILNADU DR.MGR MEDICAL UNIVERSITY
CHENNAI- 600032

*in partial fulfilment of the regulations*
*for the award of the degree of*
M.S (ORTHOPAEDIC SURGERY)
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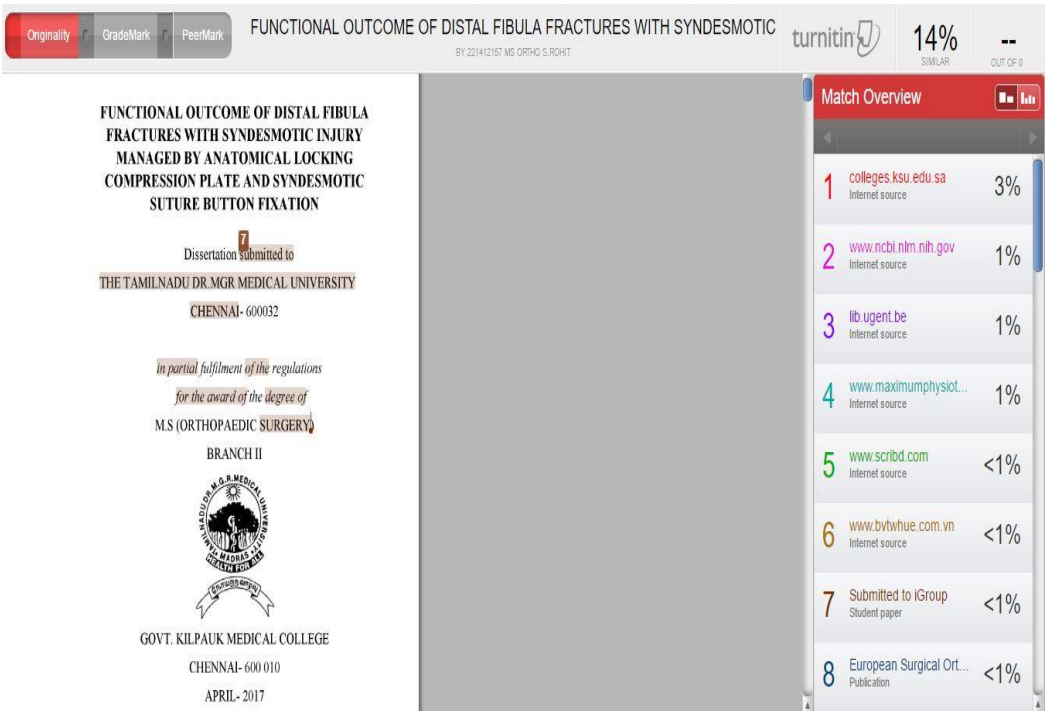
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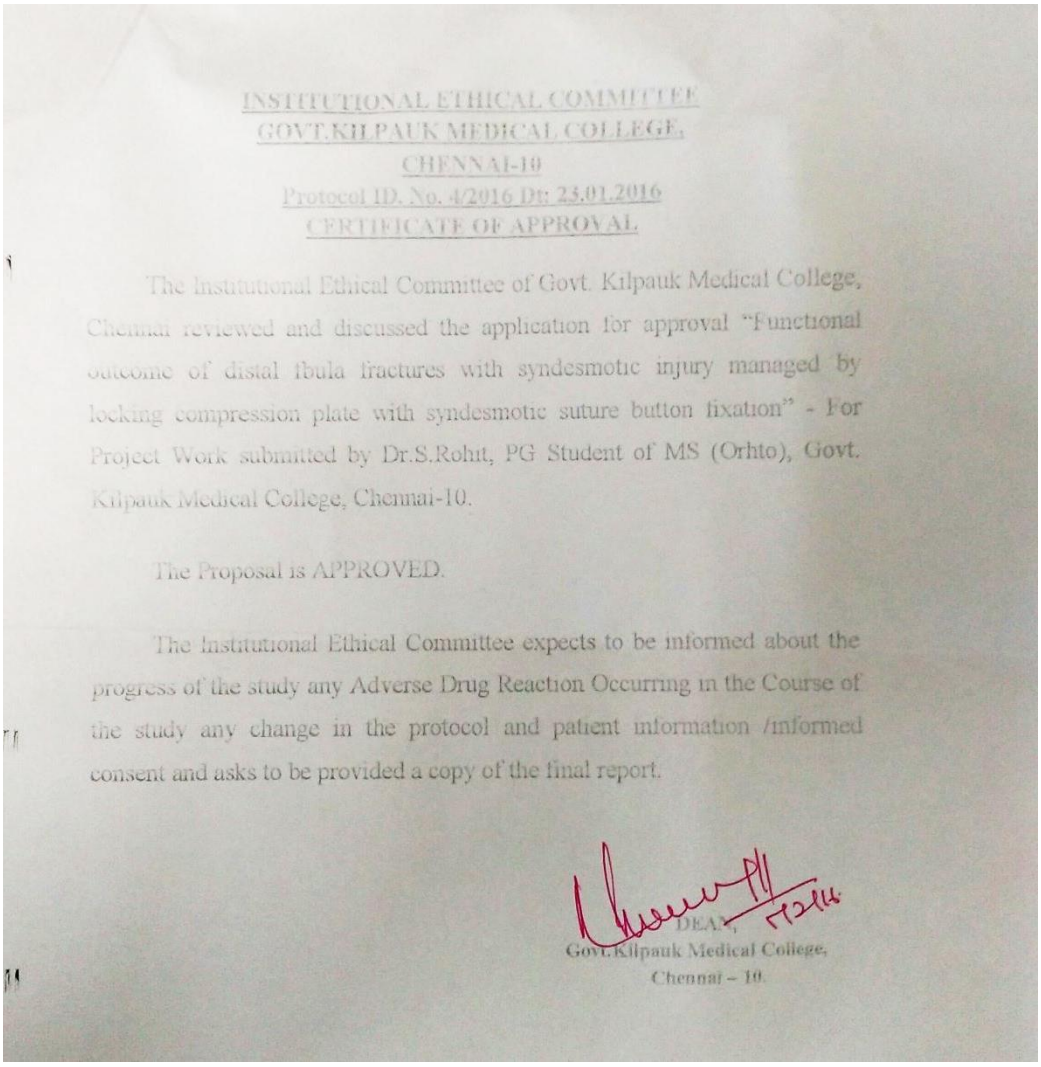

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The Institutional Ethical Committee of Govt. Kilpauk Medical College, Chennai reviewed and discussed the application for approval "Functional outcome of distal fbula fractures with syndesmotic injury managed by locking compression plate with syndesmotic suture button fixation" - For Project Work submitted by Dr.S.Rohit, PG Student of MS (Orhto), Govt. Kilpauk Medical College, Chennai-10.

The Proposal is APPROVED.

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